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ASTRO-GEOGRAPHY FOR CHILDREN.

WHILE the members of a class were discussing plans for a year's work on the history of Chicago, the children brought out the reason for the original settlement of the city at the mouth of the river on the lake. After talking over the river as the open way to the fur trader's country and the character of the surrounding region, a small boy of eight very seriously propounded the following problem, over which he had evidently spent much thought: "Which do you think," said he, "is the best way to study geography — to begin with your own place and go out, out, out, until you reach the stars, or to begin with the stars and come in and in until you reach your own place again?" Upon being told that people differ as to the wisdom of either course, and reminded that during the previous year he had studied about people who lived in very different parts of the earth, and was now to study about his own locality, he accepted the answer, satisfied to begin at home; but, while settling back contentedly, murmured: "But I shall get a book about the stars, anyway."

This story may indicate an unusual state of mind in an eight-year-old child, but, contrary to opinion, children between eight and nine take such universal views much oftener than they are given credit for so doing. The title "astro-geography" has but little meaning save as an occasionally convenient division in science for the teacher's grouping of work to be done with children under twelve.

Many of the fundamental conceptions of this same "astro-geography" kept in the teacher's mind may help in forming in the child's mind a background of feeling and interest, out of which will develop these same conceptions later on in his life, though at the time they may seem as far off from the work that he is actually carrying on as the boy's story about the stars was from Chicago geography.

The city child has so much of people, so many activities, that his naïve attitude of wonder and delight in the heavenly bodies

dies still-born, unless the organization that school and home can effect give him chance for development of that genuine interest in the marvels of the countless stars and immense distances of space which only the leisure of early youth can afford.

In the child's mind is still inherent that plasticity which makes possible the use of material that seems to the ordinary adult mind abstract, too remote to be suggestive.

A child aged eight or ten has no fear of any subject, no habit of regarding one problem as more difficult than another, because of association. Points in astro-geography, as in physiography, which take an hour's work with college students will be worked out by children in fifteen minutes. It is especially in this topic with older students that we find it more difficult to overcome the paralyzing feeling that the subject is abstruse, than to solve the real problem. The average teacher will grant that a child can use angular measure in making a clock face, when this same teacher might hesitate to go on and apply the method in getting the altitude of a star, or in attacking the subject of latitude or longitude.

With very young children, when occasion arises for their noting marked changes of length of day and night, and of season, by reference to the causes of these changes, made in a story form, the teacher can keep the ideas plastic and open to the larger universal element, although he may be occupied at the time with small results of the same changes, such as autumn fruits, the winter ice and snow, planting of his garden, or the return of the birds in the spring.

Seven-year-old children begin to ask definitely for the story of the earth; and here again, in connection with something they are carrying on — their gardening, or any other occupation — can be introduced the same story of the seasons, the explanation of the moon's phases, why only the north star seems stationary, and stories to identify others of the guiding stars of the heavens. By the use of globes and strong light, a real appreciation of the reason for the changing phases of the moon which the child sees each month may be easily attained, as well as the periodic recurrence of the eclipses; although, of course, the working out in detail of the definite position of the moon with relation to the sun and earth, which results in the different phases, might better be left until two or three years later. It has been found that the child will learn to look for the full moon rising in the east, as the sun disappears in the west, and associate that eastern position with its relation to the sun. In a graduate class in the University a professor of Greek was astonished to find that only one in his class knew where the full moon rose. This one student afterward confessed the only reason for her knowledge was that she had heard an explanation made on that day to a seven-year-old boy at home. So much of the history of past peoples and their literature is bound up with the sun, moon, stars, and the wonder of the nightly heavens, that one would question an education which, recognizing that city life now has no actual need, such as existed of old, for such knowledge, would ignore the fact that this experience must come to the child through the co-operation of the school and the home.

The equinoxes, the shortest and the longest day, are occasions to be utilized year after year to bring about a growing definiteness of idea in the child's mind of the earth's position in the solar system. The events which effectively seize on the child's imagination are the meteoric showers, the press-heralded comet, the nebulæ, and the riddle of the double star.

The amount that can be done with such topics as geographical position upon the earth, as determined by time and the altitude of the stars and sun, thus giving latitude and longitude a *raison d'être,* depends upon the background the children already possess from their previous experiences. As an illustration of what can be done when the child, through his imagination, realizes the need for a means of determining geographical position, and actually constructs a primitive method of determining the same, the following report may be of value:

The children of nine or ten who carried through this work were getting some idea of that enlargement of the known world which took place after the discovery of America, just before the beginning of the colonization period. They had had the voyages of Hawkins and Drake as introductory to the settlement of Virginia. Through the voyages of these navigators they had gained some appreciation of the necessity for a means of locating the position of newly discovered lands, as well as the need of the navigator to keep his bearings. Starting from their own sailing experiences, it was found that they had a vivid idea of sailing by points on the coast, and an appreciation of the reason why the compassless sailor hugged the shore of the continent. With the help of the compass they at first thought that the problem of sailing in a certain direction was entirely solved, but when they found that the distance north and south was as important as direction, they came up against the problem which had determined the invention of the astrolabe, or primitive quadrant and sextant. By imagining they were in typical positions upon the earth, and that the sun was on the sky's equator, they could see that, as a man traveled north from the earth's equator, the noonday sun would be lower and lower in the sky; also that the pole star at night would rise to a higher point with each northward advance, until the star was in the zenith at the pole. With the help of a globe and strings, the fact was shown them that the distance of the sun from the zenith was the same as the angle of latitude at the center of the earth, if measured in degrees on the surface of the earth, or to the latitude of the observer. This relation of the angles is easily seen intuitively. They went to work to make some instrument which would give them a ready way of finding the sun's angle or height in degrees on the horizon plane. The result was worked out in combination, each child making a form of the astrolabe where the sun's ray was received through a tube or circle. The circle of light falling on a piece of paper at the end of the tube gave a means for determining the exact angle by the pointer carried under the tube. The children were then given the correction, or the declination of the sun for that day, and by subtracting the sum of the declination and observation angles from ninety degrees they obtained the latitude of Chicago to within two-fifths degrees. The construction was the result of a long series of steps which lasted through several weeks of daily periods of an hour in length — which implies the development of an idea of angular measurement in the clock, compass and hour circles on the earth.

They then applied this method of locating one or two points in Drake's voyages, in which they had been especially interested, such as the Canary Islands, Cape Verde Islands, the coast of Virginia. They again used their latitude and longitude in a comparison of their own position with that of the Virginia colonists with reference to the difference in the severity of the winter in Virginia. They applied this again in a restatement of the zonal distribution of life on the globe with reference to their previous year's work. The need for selection of a prime meridian seemed to follow logically from the use they had made of the equator in reckoning latitude.

In such work as the above the interest in the problem and appreciation of its importance lay entirely in the relation to the voyages and discoveries which they were following, and could never be undertaken aside from such realization of its necessity. The interest in their own activity in meeting the successive difficulties in construction deepens the interest, somewhat vague and indefinite, with which they start out, while the interest in getting their observation "right" helps them realize the four or five conditions which must be met in taking even so simple an observation as this. In this way such work would seem to fulfil requirements which demand recognition of a problem, hence initiation on the child's part, and utilization by him of means suggested by the teacher to obtain an end which he appreciates. With older children, from ten to thirteen, such points can be worked out as are involved in the construction of a sun dial, of the day circle, the mapping of the chief constellations, and the working out of such a model of the solar system as is suggested in Iles's *Intuitive Geometry,* where a child, after walking blocks to place his various planets, begins to get a faint realization of the enormous distances involved in our own small planetary system. To solve through constructive geometry the problem of finding latitude from altitude of the sun or pole star is a problem which interests and demands all the powers of a thirteen-year-old child, especially when applied in the construction of the sun dial. That the child's mind is fascinated by contemplation of the great distances and by the possibilities for imaginative construction of conditions, which can be found in a study of the solar system, with its history as given in the various hypotheses of formation, has been found as true as the most enthusiastic astronomer could desire.

The main ideas of the earth as one planet in a system, of our seasons as due to the inclined axis which makes the change in direction of sunlight and relative length of day and night, may be made more telling if considered by the child, not only as changes which affect his immediate surroundings, and also the remote quarters of this globe, but as related to similar changes in the sister-planets, Mars or Venus. In the same way the idea of the motions of our satellite, if compared with the motions of other satellites, as well as connected with its varying phases as seen by the child, will gain distinctness of conception. The theories of the formation of the earth as a part of a nebulæ, once like others which can be seen today, should be repeated from year to year as affording a most important and clear illustration of the way in which scientific theories are formed, only to be replaced by others, and helps to do away with the tendency to regard a natural law as arbitrary.

If each time that such a topic is used with children it is so connected with some appreciation of the problem which gave rise to its first consideration, and the problem is elaborated through the construction by the child of some apparatus which he can in part invent, the danger of abstractness cannot be urged. Indications furnished by various experiments seem to indicate that the period just before the secondary school, before the pressure of college requirements is felt, would be the time to give an organized summary of these main conceptions of the oldest of sciences, astronomy, in close connection with one of the newest, geography.

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